

Court
~~a data processor for executing a predetermined graphic processing to generate graphic data to be stored in said memory;~~

~~output means for outputting said graphic data read out from said memory;~~

~~a memory controller for controlling data transfer between said memory and said data processor in accordance with a request from said data processor;~~

~~a first bus, having m (wherein m is an integer) bits width, connected between said memory and said memory controller, for transferring m bits of data in parallel; and~~

~~a second bus, having n (wherein n is an integer, n > m) bits width, connected between said memory controller and said data processor, for transferring n bits of data in parallel;~~

~~wherein said memory controller comprises:~~

~~a storage for temporarily storing graphic data read out from said memory in successive groups of m bits of data during a predetermined period of time through said first bus,~~

~~means for forming n bits of data using said successive groups of m bits of data and supplying said n bits of data in parallel to said data processor through said second bus based on an indication from said data processor, and~~

~~a converter for converting said graphic data temporarily stored in said storage into serial data which is provided to said output means based on an indication from said data processor.~~

Copy

10. An apparatus according to claim 9, wherein said memory controller further comprises:

a multiplexer for outputting the n bits graphic data transferred from said data processor to said first bus having m bits width in a time shared fashion.

11. An apparatus according to claim 9, wherein said memory controller further comprises:

means for generating an address signal for accessing said memory plural times, in response to a signal for accessing said memory supplied from said data processor.

4/12

X9

12. An apparatus according to claim 9, wherein graphic data to be transferred to said memory controller through said first bus is read out from said memory plural times within a unit transfer time in a time shared fashion, based on an access signal to said memory designated by said data processor.

5/13

X12

13. An apparatus according to claim 12, wherein the graphic data transferred to said memory controller is supplied to said data processor through said second bus within a time longer than twice said unit transfer time.

copy

14. A graphic processing apparatus comprising:

memory means for storing graphic data;

Copy

data processing means for executing predetermined graphic processing to generate graphic data;

output means for outputting graphic data stored in said memory means;

a memory controller for controlling transfer of data between said memory means and said data processing means in response to a request from said data processing means;

a first bus having an m-bit width (wherein m is an integer) and connected between said memory means and said memory controller, for transferring data of m bits in parallel; and

a second bus having an n-bit width (wherein n is an integer and n>m) and connected between said memory controller and said data processing means, for transferring data of n bits in parallel,

wherein said memory controller includes:

storage means for temporarily storing graphic data read out from said memory means successively in a predetermined period of time via said first bus,

means for applying said temporarily stored graphic data to said data processing means as n-bit parallel data based on an indication from said data processing means, and

converting means for converting said temporarily stored graphic data into serial data and outputting the serial data to said output means based on an indication from said data processing means.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
7010
7011
7012
7013
7014
7015
7016
7017
7018
7019
7020
7021
7022
7023
7024
7025
7026
7027
7028
7029
7030
7031
7032
7033
7034
7035
7036
7037
7038
7039
7040
7041
7042
7043
7044
7045
7046
7047
7048
7049
7050
7051
7052
7053
7054
7055
7056
7057
7058
7059
7060
7061
7062
7063
7064
7065
7066
7067
7068
7069
7070
7071
7072
7073
7074
7075
7076
7077
7078
7079
7080
7081
7082
7083
7084
7085
7086
7087
7088
7089
7090
7091
7092
7093
7094
7095
7096
7097
7098
7099
70100
70101
70102
70103
70104
70105
70106
70107
70108
70109
70110
70111
70112
70113
70114
70115
70116
70117
70118
70119
70120
70121
70122
70123
70124
70125
70126
70127
70128
70129
70130
70131
70132
70133
70134
70135
70136
70137
70138
70139
70140
70141
70142
70143
70144
70145
70146
70147
70148
70149
70150
70151
70152
70153
70154
70155
70156
70157
70158
70159
70160
70161
70162
70163
70164
70165
70166
70167
70168
70169
70170
70171
70172
70173
70174
70175
70176
70177
70178
70179
70180
70181
70182
70183
70184
70185
70186
70187
70188
70189
70190
70191
70192
70193
70194
70195
70196
70197
70198
70199
70200
70201
70202
70203
70204
70205
70206
70207
70208
70209
70210
70211
70212
70213
70214
70215
70216
70217
70218
70219
70220
70221
70222
70223
70224
70225
70226
70227
70228
70229
70230
70231
70232
70233
70234
70235
70236
70237
70238
70239
70240
70241
70242
70243
70244
70245
70246
70247
70248
70249
70250
70251
70252
70253
70254
70255
70256
70257
70258
70259
70260
70261
70262
70263
70264
70265
70266
70267
70268
70269
70270
70271
70272
70273
70274
70275
70276
70277
70278
70279
70280
70281
70282
70283
70284
70285
70286
70287
70288
70289
70290
70291
70292
70293
70294
70295
70296
70297
70298
70299
70300
70301
70302
70303
70304
70305
70306
70307
70308
70309
70310
70311
70312
70313
70314
70315
70316
70317
70318
70319
70320
70321
70322
70323
70324
70325
70326
70327
70328
70329
70330
70331
70332
70333
70334
70335
70336
70337
70338
70339
70340
70341
70342
70343
70344
70345
70346
70347
70348
70349
70350
70351
70352
70353
70354
70355
70356
70357
70358
70359
70360
70361
70362
70363
70364
70365
70366
70367
70368
70369
70370
70371
70372
70373
70374
70375
70376
70377
70378
70379
70380
70381
70382
70383
70384
70385
70386
70387
70388
70389
70390
70391
70392
70393
70394
70395
70396
70397
70398
70399
70400
70401
70402
70403
70404
70405
70406
70407
70408
70409
70410
70411
70412
70413
70414
70415
70416
70417
70418
70419
70420
70421
70422
70423
70424
70425
70426
70427
70428
70429
70430
70431
70432
70433
70434
70435
70436
70437
70438
70439
70440
70441
70442
70443
70444
70445
70446
70447
70448
70449
70450
70451
70452
70453
70454
70455
70456
70457
70458
70459
70460
70461
70462
70463
70464
70465
70466
70467
70468
70469
70470
70471
70472
70473
70474
70475
70476
70477
70478
70479
70480
70481
70482
70483
70484
70485
70486
70487
70488
70489
70490
70491
70492
70493
70494
70495
70496
70497
70498
70499
70500
70501
70502
70503
70504
70505
70506
70507
70508
70509
70510
70511
70512
70513
70514
70515
70516
70517
70518
70519
70520
70521
70522
70523
70524
70525
70526
70527
70528
70529
70530
70531
70532
70533
70534
70535
70536
70537
70538
70539
70540
70541
70542
70543
70544
70545
70546
70547
70548
70549
70550
70551
70552
70553
70554
70555
70556
70557
70558
70559
70560
70561
70562
70563
70564
70565
70566
70567
70568
70569
70570
70571
70572
70573
70574
70575
70576
70577
70578
70579
70580
70581
70582
70583
70584
70585
70586
70587
70588
70589
70590
70591
70592
70593
70594
70595
70596
70597
70598
70599
70600
70601
70602
70603
70604
70605
70606
70607
70608
70609
70610
70611
70612
70613
70614
70615
70616
70617
70618
70619
70620
70621
70622
70623
70624
70625
70626
70627
70628
70629
70630
70631
70632
70633
70634
70635
70636
70637
70638
70639
70640
70641
70642
70643
70644
70645
70646
70647
70648
70649
70650
70651
70652
70653
70654
70655
70656
70657
70658
70659
70660
70661
70662
70663
70664
70665
70666
70667
70668
70669
70670
70671
70672
70673
70674
70675
70676
70677
70678
70679
70680
70681
70682
70683
70684
70685
70686
70687
70688
70689
70690
70691
70692
70693
70694
70695
70696
70697
70698
70699
70700
70701
70702
70703
70704
70705
70706
70707
70708
70709
70710
70711
70712
70713
70714
70715
70716
70717
70718
70719
70720
70721
70722
70723
70724
70725
70726
70727
70728
70729
70730
70731
70732
70733
70734
70735
70736
70737
70738
70739
70740
70741
70742
70743
70744
70745
70746
70747
70748
70749
70750
70751
70752
70753
70754
70755
70756
70757
70758
70759
70760
70761
70762
70763
70764
70765
70766
70767
70768
70769
70770
70771
70772
70773
70774
70775
70776
70777
70778
70779
70780
70781
70782
70783
70784
70785
70786
70787
70788
70789
70790
70791
70792
70793
70794
70795
70796
70797
70798
70799
70800
70801
70802
70803
70804
70805
70806
70807
70808
70809
70810
70811
70812
70813
70814
70815
70816
70817
70818
70819
70820
70821
70822
70823
70824
70825
70826
70827
70828
70829
70830
70831
70832
70833
70834
70835
70836
70837
70838
70839
70840
70841
70842
70843
70844
70845
70846
70847
70848
70849
70850
70851
70852
70853
70854
70855
70856
70857
70858
70859
70860
70861
70862
70863
70864
70865
70866
70867
70868
70869
70870
70871
70872
70873
70874
70875
70876
70877
70878
70879
70880
70881
70882
70883
70884
70885
70886
70887
70888
70889
70890
70891
70892
70893
70894
70895
70896
70897
70898
70899
70900
70901
70902
70903
70904
70905
70906
70907
70908
70909
70910
70911
70912
70913
70914
70915
70916
70917
70918
70919
70920
70921
70922
70923
70924
70925
70926
70927
70928
70929
70930
70931
70932
70933
70934
70935
70936
70937
70938
70939
70940
70941
70942
70943
70944
70945
70946
70947
70948
70949
70950
70951
70952
70953
70954
70955
70956
70957
70958
70959
70960
70961
70962
70963
70964
70965
70966
70967
70968
70969
70970
70971
70972
70973
70974
70975
70976
70977
70978
70979
70980
70981
70982
70983
70984
70985
70986
70987
70988
70989
70990
70991
70992
70993
70994
70995
70996
70997
70998
70999
70100
70101
70102
70103
70104
70105
70106
70107
70108
70109
70110
70111
70112
70113
70114
70115
70116
70117
70118
70119
70120
70121
70122
70123
70124
70125
70126
70127
70128
70129
70130
70131
70132
70133
70134
70135
70136
70137
70138
70139
70140
70141
70142
70143
70144
70145
70146
70147
70148
70149
70150
70151
70152
70153
70154
70155
70156
70157
70158
70159
70160
70161
70162
70163
70164
70165
70166
70167
70168
70169
70170
70171
70172
70173
70174
70175
70176
70177
70178
70179
70180
70181
70182
70183
70184
70185
70186
70187
70188
70189
70190
70191
70192
70193
70194
70195<br

Cont'd

15. A graphic processing apparatus according to claim 14, wherein said memory controller includes multiplexer means for outputting n-bit graphic data transferred from said data processing means on said first bus having the m-bit width successively in a time-sharing manner.

16. A graphic processing apparatus according to claim 14, wherein said memory controller includes means for generating address signals for accessing said memory means plural times with respect to a signal for accessing said memory means applied from said data processing means.

Cont'd

17. A graphic processing apparatus according to claim 15, wherein said memory controller includes means for generating address signals for accessing said memory means plural times with respect to a signal for accessing said memory means applied from said data processing means.

18. A graphic processing apparatus according to claim 14, wherein graphic data to be transferred to said memory controller via said first bus are successively read out plural times within a transfer unit time in a predetermined period of time on the basis of an access signal to said memory means designated by said data processing means.

Copy

19. A graphic processing apparatus according to claim 15, wherein graphic data to be transferred to said memory controller via said first bus are successively read out plural times within a transfer unit time in a predetermined period of time on the basis of an access signal to said memory means designated by said data processing means.

*Amended
Cont*

20. A graphic processing apparatus according to claim 18, wherein graphic data transferred to said memory controller are applied to said data processing means via said second bus within a time period more than two times said transfer unit time.

21. A graphic processing apparatus according to claim 19, wherein graphic data transferred to said memory controller are applied to said data processing means via said second bus within a time period more than two times said transfer unit time.

22. A graphic processing apparatus comprising:
memory means for storing graphic data, said memory means being accessed by using a row address and a column address;
data processing means for executing predetermined graphic processing to generate graphic data;
output means for outputting graphic data stored in said memory means;

*Cont
DT*

a memory controller for controlling transfer of data between said memory means and said data processing means in response to a request from said data processing means;

a first bus having an m-bit width (wherein m is an integer) and connected between said memory means and said memory controller, for transferring data of m bits in parallel; and

a second bus having an n-bit width (wherein n is an integer and n>m) and connected between said memory controller and said data processing means, for transferring data of n bits in parallel; and

wherein said memory controller includes:

means for reading out a plurality of graphic data at different column addresses at a same row address from said memory means via said first bus successively in a predetermined period of time,

means for applying said read-out graphic data to said data processing means as n-bit parallel data based on an indication from said data processing means, and

converting means for converting said read-out graphic data into serial data and outputting the serial data to said output means based on an indication from said data processing means.

23. A graphic processing apparatus according to claim 22, wherein said memory controller includes means for successively generating a plurality of column addresses on the

CODES 2000-2000-2000

*AM
CONT*

Cold Box

basis of a signal for accessing said memory means applied from said data processing means.

24. A memory controller for controlling transference of data between a memory and a processor, said memory controller comprising:

m bit terminals for coupling to said memory, wherein successive groups of m bits of data is transferred through said m bit terminals between said memory and said controller by performing plural read operations within a memory cycle (where m is an integer);

n bit terminals for coupling to said processor, wherein n bits of data is transferred in parallel through said n bit terminals between said controller and said processor (where n is an integer and n>m);

storage for temporarily storing graphic data read out from said memory in successive groups of m bits of data during a predetermined period of time through said m bit terminals;

means for forming n bits of data by combining successive groups of m bits of data from said m bit terminals and supplying said n bits of data in parallel to said n bit terminals based on an indication from said processor; and

converting means for converting said graphic data temporarily stored in said storage into serial data which is supplied to output means, said output means outputs graphic